

The Risk Management of Commercial Banks

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Abstract. Commercial banks are not only the largest service sector of the real economy, but also the "bellwether" of financial industry in various countries. Their risk management has always been the focus of academic attention and hot discussion. The article reviews eight studies and discusses four main risks with their managements existed in commercial banks. The review of the four risks, interest risk, credit risk, liquidity risk and operational risk, summarizes the different methods and factors on the risk managements in commercial banks. Diverse risks have quite different methods. Some of these methods are well-established in the field of economics, whereas others are innovative, which can be examined in conjunction with other disciplines, but still need adequate empirical evidence to support them. These novel models are deserving of research and application to various forms of risk management. Moreover, some authors proposed correspondingly specific measures of risk management for commercial banks and government policymakers, while others did not.

Keywords: Interest risk; Credit risk; Liquidity risk; Operational risk; Commercial bank.

1. Introduction

Commercial banks are one of the key components of the financial industry, which is the pillar of social and economic development, and the immutable task of commercial banks is to continuously measure, accept and manage risk. Throughout the history of commercial Banks at home and abroad, the effective risk management is not only the important guarantee of commercial banks' core competitiveness and prudent management, but also the only way to realize the commercial banks' value maximization. Therefore, with people's improving recognition of the importance of the risk in the commercial banks, the approach to strengthen the management of internal and external risk problem in the commercial bank has been the focus of hot debate.

Since the 1980s, the rapid rise of economic globalization, financial liberalization and financial innovation has led to more complex and volatile risks faced by commercial banks, and the stability of the economic system has been seriously threatened. In order to preserve the stable operation of the financial system, the Basel Committee formally launched the International Agreement on Uniform Capital Measurement and Capital Standards in 1988, and put forward the concept of "capital adequacy ratio" and corresponding regulatory requirements.

At the same time, there are also many scholars who have discussed and studied the risk management of commercial banks. They have respectively studied many risks from different perspectives, such as market risk, credit risk and so on, and came up with lots of models and solutions to various risks existing in commercial banks in different countries.

Operational risk, market risk and credit risk are the three significant categories of risks that may currently be distinguished [1]. This classification of bank risks provides a summary of the risks that banks face, however it leaves out one of the most significant dangers: liquidity risk. Liquidity risk is an addition made by Gaulia and Maerinskien [2] to the categories of risk outlined in the Basel standards of capital adequacy. According to international economists Koch's classification of banking risks, foreign exchange risk, stock price risk, and interest rate risk are the three lesser risks that comprise market risk [3]. The majority of projected commercial bank risks are summarized in Figure 1.

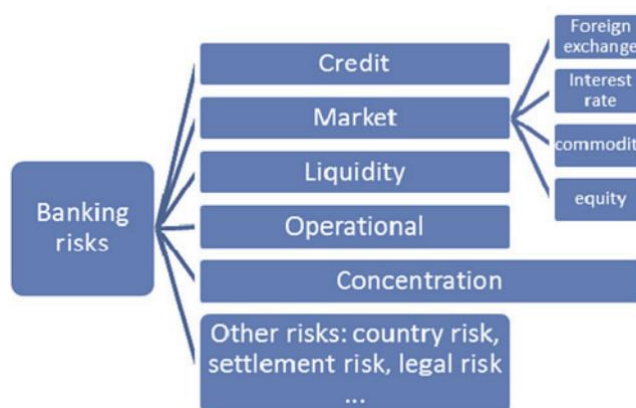


Figure. 1 The risks of commercial Bank [4]

Therefore, this paper selects four risks as research objects, including interest risk, liquidity risk, operational risk and credit risk, and aims to investigate the risk management approach of commercial banks. To be more specific, eight articles based on the above four risks are summarized and discussed in detail. In addition, almost of the commercial banks mentioned in the eight articles are selected from different countries and analyzed by various models. Finally, the conclusions focused on different risks are put forward respectively.

2. Literature review

The purpose of this article is to provide a multifaceted overview and review of the risk management of commercial banks by citing examples of existing articles. After examining the reading and analysis of the literature on the different risk managements of commercial banks, we decided to categorize this article according to risk types. In this article, eight articles are reviewed, including two articles on the interest risk, two articles on the credit risk, two articles on the liquidity risk and two articles on the operational risk.

2.1 Interest Risk

One of the most vital economic factors in economics is the interest rate [5]. In modern economy, its fluctuations affect the entire economy in addition to having a major effect on the capital and monetary markets [6]. Interest rate liberalization is a fundamental revolution that enables market capital to offer some ideal arrangements that significantly aid in the growth of a nation's economy. Note: When interest rates are liberalized, it doesn't necessarily indicate that there are no longer any restrictions on them; rather, it just means that the monetary authorities have chosen to relax their restrictions a little. Liberalizing interest rates, however, also poses significant risks and challenges to the banking industry [5]. Commercial banks now have access to capital pricing thanks to the marketization of interest rates, which also creates an important new market risk: interest rate risk [7].

For the rest of this section, the studies by Ausloos [8] and Liang [7] will be discussed, which mainly describe the influence of the deregulation of interest rates on commercial banks in China and put forward different suggestions according to the analysis.

Ausloos [8] evaluated the effects of China's interest rate liberalization on ten commercial banks with three various types of ownership in his study. Based on value-at-risk analysis, duration analysis and revisited interest rate sensitivity analysis, the approach is established. Both horizontal and vertical perspectives are analyzed. The article then investigates how banks now manage interest rate risks, including how they outperform local commercial banks and governmental commercial banks when calculating the sensitivity gap or evaluating interest rate risks. The conclusion contains a number of recommendations regarding how the risk management of such commercial banks can be redirected and how their instances might be used to provide relief for other banking issues: (1) Commercial banks should maintain a manageable level of interest margin. (2) Financial innovation products

should be expanded by commercial banks, and boosting the percentage of intermediate business appears to be an effective strategy. (3) It will be less difficult to liberalize interest rates and reduce risks if commercial banks modify their internal control systems. (4) Commercial banks in China and elsewhere need more highly qualified personnel who are capable of conducting in-depth research on both macro- and micro-economy issues. In addition, they must be able to utilize cutting-edge technology, comprehend modern principles for controlling the asset and liability structure of their commercial bank and assess interest rate risks.

Both Liang's [7] and Ausloos's [8] studies examine commercial banks in the same nation and provide recommendations. Liang analyzes not only the primary risks that commercial banks in China may face as a result of interest rate marketization, including Yield Curve Risk, Transitional Risk, Re-Pricing Risk, Basic Point Risk and Containing Option Risk, but also the current management of interest risk at commercial banks in China. Liang provides techniques for managing the interest risk faced by commercial banks in China based on this information: (1) The balance of assets and liabilities is increased in accordance with the tendency of interest rate change in order to reap the benefits of the change in interest rates, which is known as the active strategy. (2) Maintaining the balance between sensitive assets and sensitive liabilities is also known as a defense strategy. (3) China should prioritize the growth of the national debt futures market.

2.2 Credit Risk

In this sub-section, a summary analysis of articles about the credit risk of commercial bank is provided. Nowadays, the primary risk that the majority of banks are confronted with is credit risk, which is the possibility that a borrower will be unable to make timely payments on their loans. or in accordance with the predetermined terms [9]. The eliminating all potential sources of risk from any kind of investment is known as credit risk management [9]. Modern risk measurement models have been extremely important in measuring credit risk since they are founded on modern financial theory and innovative credit instruments [10]. At the moment, linear analytic approaches are primarily used in empirical investigation on the link between the credit risk of commercial banks and macroeconomic variables [11]. As a result of the small sample size and restricted analytic techniques, however, there is still a dearth of study on the nonlinear link between commercial banks' macroeconomic fundamentals and credit risk [11]. Neural network models are self-organizing and self-learning systems that do not require a defined function form before application, hence avoiding any potential errors brought on by a subjective function form [11]. Based on this, the rest of this section will discuss the studies by Shan [6] and Wang [12], which primarily describe the implementation of several neural network models in commercial banks' credit risk management.

To model and approximate the commercial banks' non-performing loan rate, Shan [11] built the BP neural network and GRNN models, with a focus on risk assessment and credit management for commercial banks. Back propagation neural network is another name for BP neural network with the input layer, hidden layer, and output layer. Figure 2 depicts the structure. While, the neural network for generalized regression (GRNN) is a subset of the network that has the above three layers and the addition layer. Figure3 depicts the structure. According to the data, in contrast to the BP, which has a poor accuracy of fitting but a high accuracy of prediction, the GRNN has a high accuracy of fitting but a low accuracy of prediction.

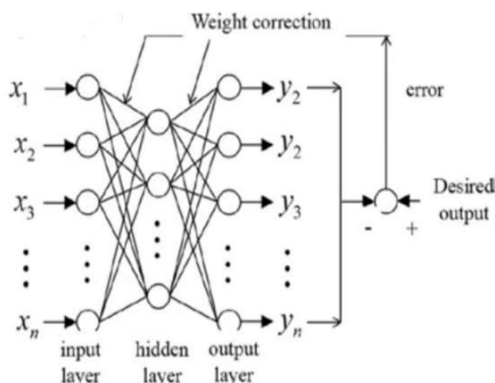


Figure. 2 BP Neural Network Structure Diagram [11]

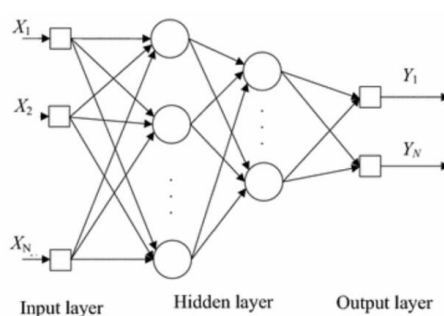


Figure. 3 GRNN neural network structure diagram [11]

BP neural network and a mutation genetic algorithm were integrated by Wang [12], who concentrated on the credit risk evaluation in commercial banks. In his study, the mutation genetic algorithm was used to improve the major parameter combination of the neural network in order to maximize neural network efficiency. The neural network was utilized as the primary modeling instrument for the assessment of credit risk in commercial banks. The assessment model indicated in this study is more accurate than 65% of the time, and the assessment results enhanced by this algorithm are acceptable more than 85% of the time, according to the verification of many evaluation models. Compared to the traditional credit scoring system, which is only approximately 50% accurate, credit risk assessment with neural network technology is more accurate. It has been demonstrated that the improved method outperforms the conventional neural network approach in terms of performance. It is theoretically and practically significant for the development of the commercial banks' prevention system for credit risk.

2.3 Liquidity Risk

One of the most significant risks to which banks are exposed [4] is liquidity risk, which is the capacity of a bank to immediately satisfy all of its financial obligations made during commercial operations, according to the Basel Committee (2015). Liquidity serves as a qualitative indicator of the financial stamina of banks in this regard. This risk arises when a financial institution does not have enough ability to cover its liabilities without adversely effecting its regular business operations and financial situation. As a result, banks are either forced to incur excessive expenses to generate liquidity or are unable of meeting immediate liquidity requirements [13]. The cornerstone of a commercial bank's successful management of liquidity risk is liquidity risk measurement [14]. Liquidity management may reduce the likelihood that major difficulties will occur in the future [3].

The study by Mazur [15] compares correlation in two groups, containing banks in the nations of the New EU and the nations of the Old EU. Based on two indicators of liquidity risk, the study estimates the same group of factors that jointly produce macroeconomic factors and microeconomic factors. According to the estimation, the liquidity level in the former EU member states is clearly impacted by the interest rate on the interbank market. The fact that there is a strong connection

between the actual rise in interest rates for O/N deposit transactions on the market for unsecured interbank deposits and the increase in liquidity among banks in the old European Union suggests that banks' participation in the money market increased as a result of the increase in interest rates. However, in nations joining the new EU, the rise in this rate is not equal to the rise in total liquid assets. In countries that make up the so-called European Union, there is little evidence that there is a correlation between short-term changes in the interbank market interest rate and the amount of liquidity retained by individual banks. As a result, it appears that the rise in O/N interest rates of the interbank markets of the new European Union countries does not increase the liquidity level in the short period. This may be a sign that banks use a long-term strategy to build their liquid asset portfolios rather than aiming to maximize short-term profits.

The study by Tu [13] identifies the factors that account for the commercial banks' liquidity in Vietnam's financial system between 2010 and 2015. Commercial banks benefit from the interbank market by having more liquidity, and the liquidity risk increases with loan size. According to research employing the OLS regression method, great management of credit risk has a favorable influence on managing liquidity risk, and the long-term interest rate has a negative impact on the commercial banks' liquidity. Additionally, this study offers policymakers from the government of Vietnam and the bank of the State on how to manage bad debts, expand access to capital, tighten internal controls on bank liquidity management, and enhance credit quality (strengthen the legal structure for liquidity risk management; aid commercial banks in varying their capital sources).

2.4 Operational Risk

Along with market risk and credit risk, operational risk is one of the three major concerns that banks must promptly handle [16]. In financial services, operational risk is the possibility of accruing losses because of the failure of internal processes, people, or systems, or the occurrence of unforeseen external events. It includes, for example, risks associated with the process and execution management, such as negligent client asset loss, data entry errors, accounting problems, and missed mandatory reporting [16]. In tandem with the continual development of society and the gradual internationalization of the financial sector, commercial banks face an increasingly complicated operational risk. This necessitates that commercial banks successfully control operational risk, as failure to do so not only have a significant influence on the operations of commercial banks and their competitiveness, but also can even result in mortality [17].

There are currently worldwide and Russian operational risk management approaches. The so-called advanced procedures fall under the first category in Vasiliev's study [18]. These procedures call for a credit institution to maintain a sizable database of operational risk events and expensive software to do calculations. This comprises the Scorecard Approach (SCA) or a system using assessment cards, the Loss Distribution Approach and the Internal Measurement Approach (IMA). Due to significant financial expenditures and a lack of accumulated data, many small credit institutions are unable to implement modern technologies. The basic indicative approach (BIA), the standardized approach (TSA), and an alternative standardized approach (ASA) are simple evaluation approaches that are also used internationally and are popular in Russia (ASA). On the basis of global and Russian practices, the paper suggests an "ideal" approach. The proposed management model is now being gradually applied in banks and is already showing results. Since the beginning of 2015, the calculated risk level at PJSC BANK TCB (Public Joint-Stock Company Transcapital bank) and PJSC Bank Vozrozhdenie has fallen by 13% and 4%, respectively. The actual operational losses have respectively dropped by 23 percent and 15 percent. It can be inferred that the devised model is effective and required by the aforementioned banks. PJSC PJSC Bank Vozrozhdenie" and transcapital bank" won't lessen the operational risk exposure they may have thanks to a better management structure, but they will also be able to increase their profits by decreasing expenses, thereby enhancing the efficiency of their operations.

Xu [16] investigates how workload and the occurrence of operational risk occurrences are related in an effort to inform better labor decisions. In order to achieve this objective, a data collection from

a commercial bank in China is used in this investigation, containing 1,441 operational risk occurrences over a period of 16 months and concludes that the operational risk error rate is U-shapedly affected by workload. To be specific, when workload grows, the mistake rate associated with operational risk events decreases and then rises. Moreover, while burden is low, employees have a tendency to take performance-seeking risks, whereas when workloads are heavy, cognitive multitasking tends to degrade quality. This article addresses branch staffing practices aimed at lowering operational risk losses based on the empirical examination of the causal link between workload and incidences of operational risk. It is concluded that, depending on the case, using a flexible staffing guideline can minimize operational risk occurrences by 3.2% to 10%. Additionally, a modest level of flexibility can be introduced to the procedure by enabling staff to switch branches or business lines within the same branch on a quarterly basis.

3. Summary of the literature review

The aforementioned articles analyze the risk management of commercial banks from various angles. The focus of this article is on four risks: interest risk, credit risk, liquidity risk, and operational risk. Despite considerable methodological discrepancies, there are some parallels between these articles. In general, regardless of their individual methodologies, the aforementioned studies reach findings centered on distinct dangers.

This paper begins by analyzing two publications concerning interest risk. One of the most crucial aspects of the economy is the interest rate [5]. Ausloos's study examined the current handling of interest rate risks via sensitivity analysis, duration analysis, and value-at-risk. And Liang's article analyzed not only the key risks that commercial banks in China would face during the process of the interest rate marketization, such as Transitional Risk, Re-Pricing Risk, Containing Option Risk, Basic Point Risk and Yield Curve Risk, but also the current management of interest risk at commercial banks in China. Both articles provide recommendations for commercial banks in the area of interest risk.

The study then follows with a review of two publications on credit risk, which is the primary risk most banks face. To model and predict the commercial banks' non-performing loan rate, Shan compared the BP neural network and GRNN model. The results show that in contrast to the BP, which has a poor accuracy of fitting but a high accuracy of prediction, the GRNN has a high accuracy of fitting but a low accuracy of prediction. In addition, Wang integrated a BP neural network with a mutation genetic algorithm and discovers that the optimized method outperformed the traditional neural network algorithm in terms of performance.

This study also gives a short examination of two articles about the liquidity risk. The paper by Mazur studied the factors of liquidity risk by comparing dependencies in the Old EU and the New EU respectively, and concluded that the increase in O/N interest rates urges banks operating in the area of the Old EU to participation in the stock market, but not those in the nations of the New EU. Utilizing the OLS regression method, Tu's research analyzed determinants that describe the commercial banks' liquidity in the Vietnamese financial sector between 2010 and 2015 and offered many recommendations for commercial banks and decision-makers from the State Bank and the government.

Finally, the operational risk management of commercial banks is studied. The essay by Vasiliev presents a "optimal" model for managing operational risk based on international and Russian customs, and The produced management model is currently being implemented in banks with positive results. According to Xu's investigation, operational risk mistake rate is influenced in a U-shaped manner by workload.

For the eight papers analyzed in this paper, we used the same coding sheets to classify them (Table 1). Author(s), Methodology, Principal propositions/findings, and Risk were incorporated into the categorizing procedure.

Table. 1 Studies on the Risk Management of Commercial Banks

Risk	Author(s)	Methodology	Main propositions/findings
Interest risk	Marcel Ausloos, Parmjit Kaur, Qianhui Ma, Babar Syed, Gurjeet Dhesi.	value-at-risk analysis, interest rate sensitivity analysis and duration analysis	<p>(1) Commercial banks should maintain a manageable level of interest margin.</p> <p>(2) Commercial banks ought to increase their offering of innovative financial products.</p> <p>(3) Commercial banks should adapt the inner control system to achieve interest rate liberalization.</p> <p>(4) Commercial banks need more highly qualified professionals.</p>
Interest risk	Tao Liang	divide the interest rate risk by time sequence	<p>(1) To gain from the change in interest rates, the balance of assets and liabilities should be increased.</p> <p>(2) The balance between sensitive assets and sensitive liabilities should be maintained.</p> <p>(3) The growth of the market for futures on national debt should be a top objective for Chinese commercial banks.</p>
Credit risk	Shan Zhirui	GRNN and BP neural network model	In contrast to the BP, which has a poor accuracy of fitting but a high accuracy of prediction, the GRNN has a high accuracy of fitting but a low accuracy of prediction.
Credit risk	Wang Xiao gang	BP with a mutation genetic algorithm	After validation of several assessment models, the assessment model proposed in this research is more accurate than 65%, and the assessment outcomes improved by the mutation genetic algorithm are more acceptably accurate than 85%.
Liquidity risk	Wójcik-Mazur A, Szajt M.	factor analysis	<p>(1) The increase in O/N interest rates urges banks in the region of the Old EU to enhance their money market involvement.</p> <p>(2) In nations of the New EU, the rise in this rate is not proportional to the rise in total liquid assets.</p>
Liquidity risk	Thuy T.H. Nguyen, Tu T. T. Tran, Yen T. Nguyen, Long Tran.	OLS regression method	<p>(1) The interbank market improves the liquidity of commercial banks.</p> <p>(2) The greater the size of the loan, the greater the liquidity risk.</p> <p>(3) Effective management of credit risk positively influences liquidity risk management.</p> <p>(4) The link between the long-term interest rate and the liquidity in commercial banks is inverse.</p>
Operational risk	G. Shevashkevich M., N. Donskaya E, V. Klimovskih N., I. Vasiliev I., A. Smelov P.	TSA, BIA and ASA	The risk level evaluated by the fundamental approach has fallen by 13% at PJSC BANK TCB (Public Joint-Stock Company Transcapital bank) and by 4% at PJSC Bank Vozrozhdenie since the first quarter of 2015. The actual operational losses have dropped by 23 percent and 15 percent, respectively.
Operational risk	Xu Yuqian, Netessine Serguei, Tan Tom Fangyun	factor analysis	The influence of workload on operational risk error rate is U-shaped.

4. Conclusion

Not only are commercial banks the largest service sector of the actual economy, but they are also the "barometer" of the financial industry in numerous nations. So important that the risk management of commercial banks is worth studying by scholars. Therefore, this article summarizes eight pieces of literature from each of the four risks - interest risk, liquidity risk, operational risk and credit risk. From the studies related to the different risks, it seems that each risk in commercial banks has multiple measuring methods and various kinds of management approaches. The research can be analyzed without employing statistical models, or by utilizing traditional economic attribution models, or by combining economic factors with neural network models. Some of these models are well-established in the field of economics, whereas others are innovative, which can be examined in conjunction with other disciplines, but still need adequate empirical evidence to support them. These novel models are deserving of research and application to various forms of risk management. In addition, some authors have advocated particular risk management strategies for commercial banks and government policymakers, which is also worthwhile to learn from previous generations, while others haven't. Therefore, the primary contribution of this work is to provide a summary of models and specific measures for the management of the four important risks affecting commercial banks, which is useful for those who focused on the study on the topic of commercial bank risk management. Studying the risk management of commercial banks has an important role to play, but it is also a challenging area. It is necessary to explore more risk management methods in commercial banks especially under different conditions in future research, such as against the backdrop of the COVID-19 pandemic, in the context of the financial crisis and so on.

References

- [1] Crouhy M, Galai D, Mark R. Risk management. McGraw-Hill. New York. 2007.
- [2] Gaulia A, Mačerinskienė I. Adaptation of bank's X risk management model to the new basel capital accord using algorithm based on paired comparison [J]. Vadyba [Vilniaus universitetas], 2006 (2): 48-57.
- [3] Koch TW, MacDonald SS. Bank Management. Cengage Learning. United States of America. 562 p. 2006.
- [4] Jasienė Meilė, Martinavičius Jonas, Jasevičienė Filomena, et al. Bank liquidity risk: analysis and estimates. Business, Management and Education, 2012, 10(2).
- [5] Dell'Araccia G, Laeven L, Marquez R. Real interest rates, leverage, and bank risk-taking. J Econ Theory, 2014, 149(1):65-99.
- [6] Drakos AA, Kouretas GP, Tsoumas C. Ownership, interest rates and bank risk-taking in Central and Eastern European countries. International Review of Financial Analysis, 2016, 45(5):308-319.
- [7] Liang Tao. Research on interest rate marketization and risk control of commercial banks [C]. Proceedings of 2017 3rd International Conference on Economics, Social Science, Arts, Education and Management Engineering (ESSAEME 2017), 2017:978-981.
- [8] Ausloos Marcel, Ma Qianhui, Kaur Parmjit, et al. Duration gap analysis revisited method in order to improve risk management: the case of Chinese commercial bank interest rate risks after interest rate liberalization. Soft Computing, 2019,1-19.
- [9] Oleiwi AT, Nadhim MH . The relationship between credit risk management practices and profitability in Malaysian commercial bank's. International Journal of Engineering and Advanced Technology, 2019, 8(5C).
- [10] Zhao Yawen, Sun Yongmei. Credit risk measurement study of commercial banks based on the innovation discrete Hopfield neural network model [J]. Journal of Global Business and Trade, 2021, 17(2).
- [11] Shan Zhirui. Credit risk assessment and prediction model of commercial banks. Financial Engineering and Risk Management, 2021, 4(4):33-37.
- [12] Wang Xiaogang. Analysis of bank credit risk evaluation model based on BP neural network. Computational intelligence and neuroscience, 2022, 2724842:1-11.

- [13] Tu T. T. Tran, Nguyen Yen T., Nguyen Thuy T. H., et al. The determinants of liquidity risk of commercial banks in Vietnam. *Banks and Bank Systems*, 2019, 14(1):94-110.
- [14] Wang Liang, Huang Chongzhen. Liquidity risk measurement of commercial bank based on EGARCH-POT model. *International Journal of Applied Mathematics and Statistics™*, 2013, 48(18).
- [15] Wójcik-Mazur A, Szajt M. Determinants of liquidity risk in commercial banks in the European Union. *Argumenta Oeconomica*, 2015, Nr 2 (35), s. 25-47.
- [16] Xu Yuqian, Tan T, Netessine Serguei. The impact of workload on operational risk: evidence from a commercial bank. *Management Science*, 2022, 68(4):2668-2693.
- [17] Liu Lijuan. Study on operational risk management of neural network commercial bank. *Proceedings of 2016 4th International Education, Economics, Social Science, Arts, Sports and Management Engineering Conference (IEESASM 2016)*, 2016: 1013-1016.
- [18] Vasiliev I.I., Smelov P.A., Klimovskih N.V., et al. Operational risk management in a commercial bank [J]. *International Journal of Engineering & Technology*, 2018, 7(4.36):524-529.